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A PILGRIMAGE IN NORTHEASTERN AFRICA, WITH STUDIES OF DESERT CONDITIONS

By WILLIAM HERBERT HOBBS

It is a significant fact that the men who have profoundly modified the foundations of natural science, those whose writings mark on the long journey the important stations at each of which new outlooks have been afforded, have with few exceptions traveled to distant regions where nature could be studied in her widely varied aspects. Alexander von Humboldt and Leopold von Buch, Wallace and Darwin and Huxley, Lyell and Dana: these are names that come at once to mind. For the most part these great scientists antedated the modern period of intense specialization, with ever greater narrowing of the field of study; but there is no reason to doubt that for the broader systematic phases of natural science, and for the earth sciences in particular, conditions have not greatly changed in this regard. The geographer or the geologist who would correctly interpret the earth's past records must have himself observed nature in different latitudes and under different conditions of climate.

In so far as their means permit them to do so, American students of geology and geography, in common with their non-scientific compatriots, are believed to avail themselves of opportunities for travel; though probably less than formerly, when the lack of well-equipped graduate departments in America led them to pursue their studies at European and especially German universities. The large expense entailed by extended travel, and its opportunities for general culture, will usually counsel an itinerary so planned as to combine professional with cultural studies. Without access to the necessary literature, which is often scattered and not readily accessible, such an itinerary may not be easy to lay out; and a real need exists for collated information concerning scientific pilgrimages of this nature.

Our universities being so generally surrounded by country which is well watered, there is a special need that students of geology and geography

should as early as possible become familiar with the widely different aspects which are presented by the arid regions. Of deserts easily accessible from Europe, Egypt and the Sudan have perhaps the most to offer, while affording in addition the opportunity to study the most ancient and wonderful of human monuments. It is therefore proposed here to outline a geological pilgrimage in this region, where the conditions of humid and arid climate meet with more sharply defined contacts than elsewhere upon our planet.

The many possible routes to Egypt from Europe represent varying degrees of comfort and interest, the quickest being that from Brindisi in southeastern Italy. This route, like those from Naples, permits the student to make interesting excursions into the famous volcanic districts of the Italian peninsula. The route to Egypt via Constantinople and the Piræus (Athens) offers in normal times such allurements in the opportunities for observing Oriental life and customs and for traversing the theater of action of great modern wars as perhaps to compensate for the somewhat greater expense. The return from Egypt may be made to advantage by a different route, the cheapest and not the least interesting being by so-called "intermediate" steamer of one of the British lines from India with ports of call at Port Said and Malta. The chief disadvantage of such a passage is that the boats seldom sail on scheduled dates, and one must be prepared for some delay. Malta, which is of itself exceptionally interesting and offers access by steamer to Tunis with its hinterland of desert, has a daily service by small steamer with Syracuse in Sicily, the trip being made in eight hours.¹

The approach to Alexandria from the sea affords one of the most remarkable of physiographic contrasts. Out of the low green plain of the fertile delta rises the slim column of the Damietta light, and, as we approach nearer, the minarets of the mosques and the tall chimneys of factories come into view: but this picture of fruitful soil and of human occupation is joined in sharpest contrast with the barren yellow *hamada* of the Libyan Desert, which stretches away westward into the distance. With slightly varying aspects this contact of desert and fertile land is one which the traveler will have ever before him in Egypt, until by its very repetition he ceases to be surprised at it and comes to understand why the Nile is in Arabic *bahr*, "the river." Its waters alone give life, and, were the groaning irrigating devices, the *shâdûf* and *sâkyeh*, to cease working, the strips of land along the banks would soon revert to desert.

While in Cairo the student will not fail to visit the Museum of Geology on the Sharia Sheikh Rihan, where he will find in frames general and special geological maps of Egypt and in cases a collection of the characteristic rocks and fossils of the country. The type specimens of the gigantic tortoise *Testudo Ammonis* and the Oligocene rhinoceros *Arsinoë-*

¹ Steamship lines are likely to be profoundly modified as a result of the world war.

therium are to be found here and, further, an excellent collection to illustrate the processes of desert weathering and erosion. Across the Nile

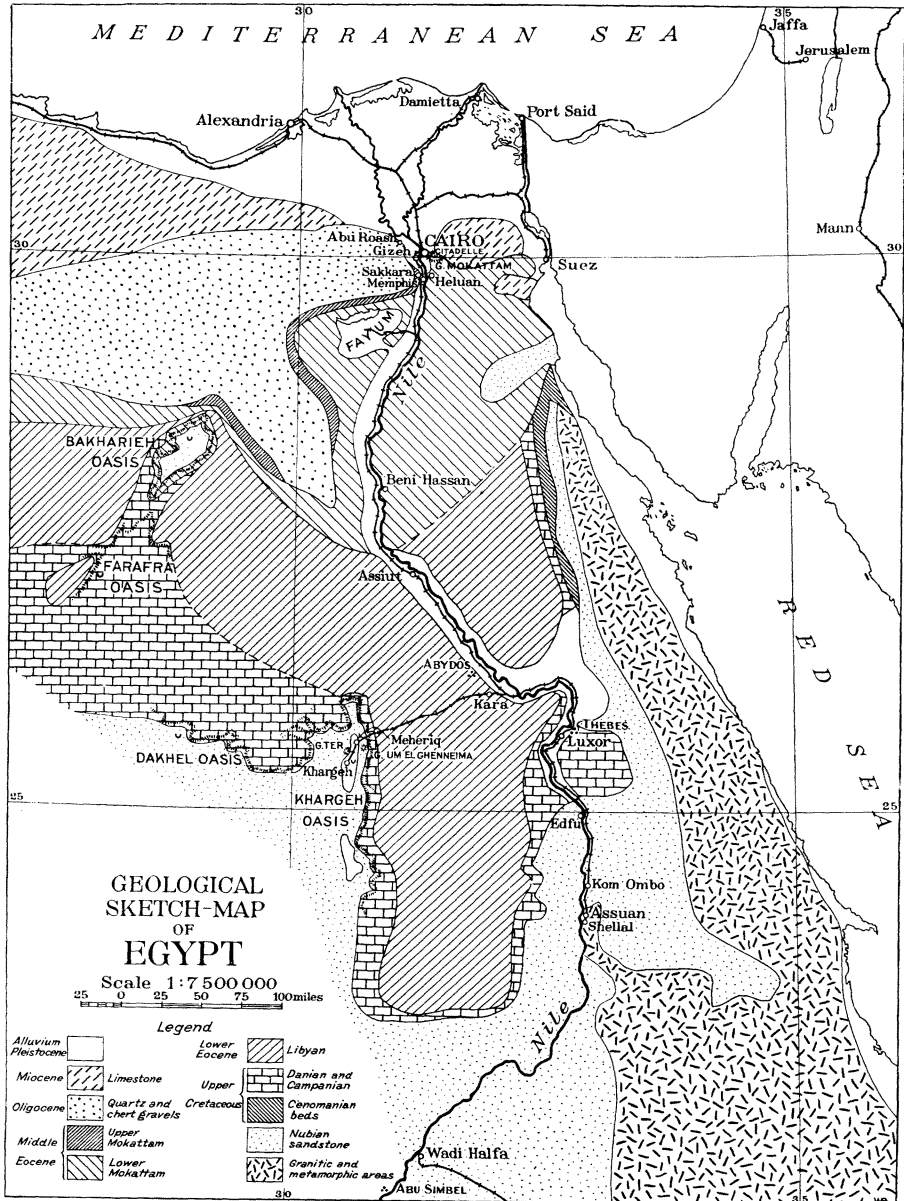


FIG. 1—Geographical sketch-map of Egypt. Scale 1:7,500,000. (After W. F. Hume: The Effects of Secular Oscillation in Egypt during the Cretaceous and Eocene Periods, *Quart. Journ. Geol. Soc. London*, Vol. 67, 1911, pp. 118-148.) The geological symbolism does not extend east of the Suez Canal.

in Gizeh are the attractive Zoological Gardens, with representatives of African animals, birds, and trees, the latter unfortunately seldom labeled,

so that one may really learn more of the Egyptian flora by a visit to the Ezbekiyeh, or public park, in the heart of Cairo.

A first bowing acquaintance with the Eastern, or Arabian, Desert may be made from Cairo, going by tram to the foot of the Citadelle and thence either on foot or by donkey past the Mosque of Mohammed Ali to the summit of the Mokattam Hill. This mesa-like hill is of nummulitic Eocene limestone and has supplied the name to the great limestone formation of Egypt which extends on both banks of the Nile to and beyond Luxor, to be there replaced by the Nubian sandstone of Cretaceous age (Fig. 1). During the Pliocene or late Tertiary time the valley of the Nile was a fiord-like arm of the sea, as is shown by the *Clypeaster*-bearing deposits which are exposed near the west wall not far from Abadiyeh. The evidence of the subsequent elevation and its measure is indicated by the former shore-line on the Mokattam Hill, now at an elevation of about 200 feet above tide.

In visiting the Mokattam Hill one may continue his journey to the small petrified forest, where fragments of fossil wood, due to a silicification in Oligocene times, may be collected; but if possible the trip should be so timed as to view the sunset from the summit of Mokattam. Particularly after a strong wind, when the lower atmospheric layers are charged with the fine dust of the desert, the many hues of yellow and orange and red form a background to the range of pyramids which is not easily forgotten.

The great pyramids of Gizeh and the desert west and north of them as far as Abu Roâsh will repay at least two days of study, since here are opportunities rarely equaled to note the various phases of the desert weathering processes and sand polishing and to make observations stratigraphic and tectonic about the local uplift which in post-Mokattam time brought the faulted Cretaceous series into view in the core of the dome.²

Before outlining other excursions in Egypt it may be well to point out that the student who is a good walker and used to finding his own way with map and compass can well dispense with donkeys, donkey boys, and dragomans except on such longer excursions as are best made by camels. The Arab donkey boy in particular is found to have such limited knowledge of desert routes and such fear of undertaking a new one that he becomes a positive nuisance; and his patient little beast, unless cruelly beaten, is hardly able to make better time than the traveler afoot. Moreover, in the winter season the cool wind almost constantly blowing over the desert makes walking far from exhausting, though helmet and sun spectacles are necessary to shield one from the sun's rays. In this season, when alone the journey should be made, the heavy bottle of drinking water usually provided with luncheons may be dispensed with, for the

² H. J. L. Beadnell: The Cretaceous Region of Abu Roâsh near the Pyramids of Giza, *Geol. Surv. of Egypt Rept. for 1900, Part II*, Cairo, 1902.

fresh oranges or mandarins, which for a few piasters the traveler may purchase in sufficient number from the street vendors, will remove any sensation of thirst.

The necessary maps for excursions in Egypt can for the most part be obtained at the office of the Museum of Geology, Cairo, or at Diemer's book store in the Sharia Kamel, the valuable special maps by Schweinfurth and the geographic works treating of Egypt being obtainable at the latter place only. The topographic map sheets are published on two scales, namely, 1:50,000 and 1:10,000; and after laying out one's itinerary the necessary sheets should be procured at the museum office. They are, however, expensive and in most cases not indispensable. What the student cannot afford to do without is Professor Johannes Walther's "Das Gesetz der Wüstenbildung."³ Not only is Professor Walther the "desert geologist" *par excellence*, and the new edition of his book the best treatment of what might be called the technique of travel of the geologist in arid lands, but its special adaptability to Egypt and the Anglo-Egyptian Sudan is shown by the fact that a majority of the localities cited for illustration and fully one-half of the 150 half-tone views which embellish the work are from photographs taken either in Egypt or in the Sudan.

Before leaving Cairo as a base, an excursion should be made to Heluan (35 minutes by train) and thence to the Walthertal, the Wadi Hof and neighboring Reil Schlucht, and, if time permits, to the Wadi Gerraui and its ancient dam, in order to observe weathering effects in the hewn blocks.⁴ In case the latter be omitted, the trip can be accomplished in one day, and it affords the opportunity to observe cliffs undercut through surface concentration and expansion of salts within the rock, combined with etching of the blown sand; likewise mushroom rocks, wadi location along fractures, the "blind" ends of wadis, etc. For this excursion Sheet II of the Schweinfurth series of maps⁵ is indispensable unless one has Walther's book, in which a part is reproduced, since the newer government maps have abandoned the system of local names given by Professor Schweinfurth.

An excursion should also be made from the Great Pyramids of Gizeh upon the west bank of the Nile along the margin of the desert southward to Sakkâra and Memphis, the traveler returning to Cairo by evening train from the station of Bedrashein. The route will begin at the Mena House, where, if desired, donkey or camel can be procured. Here, as elsewhere in Egypt, it is best to bargain directly with a cameleer of the more responsible type, in order to avoid the commission which is secretly exacted by the hotel and is often as much as thirty to fifty per cent of the price. In passing the Great Pyramids the remarkable effects of weathering are to be noted low down within the range of action of the wind-blown sand, which

³ Das Gesetz der Wüstenbildung in Gegenwart und Vorzeit, 2nd edit., Quelle & Meyer, Leipzig, 1912.

⁴ Cf. Walther, *op. cit.*, pp. 23, 34, 117, 199, whence nomenclature.

⁵ Aufnahmen in der östlichen Wüste von Aegypten, in 10 sheets, 1:200,000 (except Sheet I, 1:30,000), Reimer, Berlin, 1897-1910.



FIG. 2.

FIG. 2—The high flood plain of the Nile at Luxor, its surface about 22 feet above low-water level. View through gateway overhung with *Bougainvillea*, looking westward to the terrace on the further shore and to the Libyan *hamada* faintly outlined beyond. Berber boatman in feluca half hidden in the foreground.



FIG. 3.

FIG. 3—Mosque in the main square of the village of Khargeh.

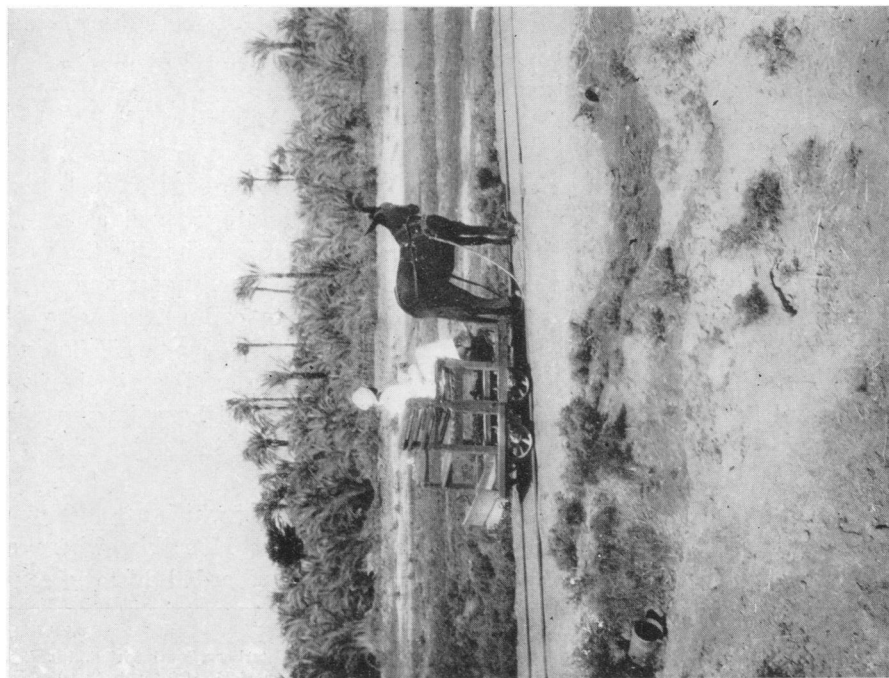


FIG. 4—Mule tram as means of conveyance on railway, Khargeh oasis.

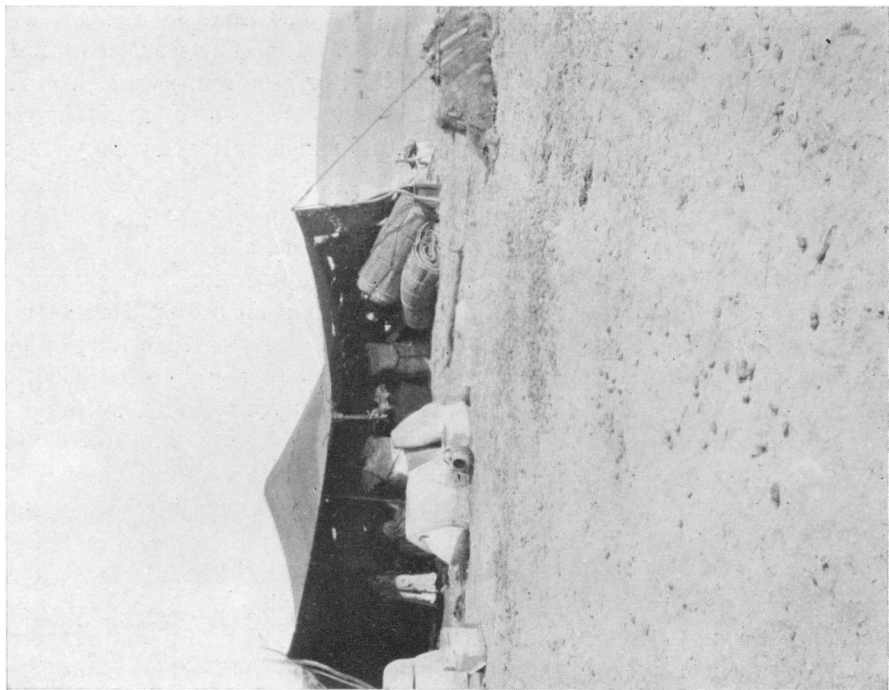


FIG. 5—A Bedouin encampment in the Khargeh depression.

has here evidently been carried upward at various times in the past as a result of dune accumulations about the base. The effects are most noteworthy on the south and west of the middle, or Khefren, pyramid.⁶ The Sphinx brings into contrast the upper and lower divisions of the Mokattam limestone and exhibits well the manner in which softer layers yield to the attack of the blown sand.

Continuing along the desert margin we stop to observe the numerous flints, which here form an armor to the surface as a result of the lifting and removal of all finer materials by the wind—deflation. The residual flints remain entire in but few instances. Nearly all are split or sprung as a result of the temperature changes, which here have a wide range. The main result, we are inclined to believe, should be charged to diffission, or splitting when the stone, highly heated in the sun, is splashed by the cold dash of a desert downpour.

Arriving at the necropolis of Sakkâra the student of science will be amazed in contemplating the beautiful mural decorations in the *mastabas* of Ti and Ptahhotep, which prove beyond question that the Nile Valley, in the ancient days when Memphis flourished, abounded in large and small game—lion, antelope, oryx, ibex, gazelle—such as is found today in that paradise of sportsmen far to the southward in the region of abundant rains. With these African types there is occasionally seen the stag, a northern animal, and there are flocks of birds in great numbers. While the figures placed beside these animals and birds to indicate their numbers are without doubt gross exaggerations (in one instance 121,200), the former abundance of wild animal life in the Nile Valley must be admitted, since hunting scenes occupy so large a place in the reliefs.

By those who do not admit that important changes of climate have occurred within historic time, the disappearance of the game fauna from the Nile Valley is ascribed either to a disease epidemic, such as the recent rinderpest in South Africa, or to unrestricted hunting, such as caused the practical extinction of the American bison. This is hardly the place to marshal the evidence that great desiccation has actually occurred in the eastern Sahara within historic time, but rather to call attention to the necessity of a critical stage in the process of desiccation at which animal and vegetable life quite suddenly disappear. Such a crisis arrived in the Transvaal in 1913, and this has been vividly described by a lawyer with keen powers of observation who resided at Rietfontein in the heart of the district.⁷

But it is the cities of the dead and not of the living which are in Egypt left for our inspection. Upon the site of ancient Memphis, where as nowhere else in the world geology and so-called recorded history come

⁶ Cf. Walther, *op. cit.*, pp. 111-115.

⁷ Eugène N. Marais; Notes on Some Effects of Extreme Drought in Waterberg, South Africa, *Ann. Rept. Smithsonian Inst.* for 1914, pp. 511-522 (reprinted from *Agric. Journ. of Union of So. Africa*, Feb. 1914.)

into closest contact, we look down upon a chaos of ruined adobe walls. So strong was the belief of the ancient Egyptian in the immortality of his *ka*, or soul, and in the brevity of his life this side of the grave that it was only for the future life of his spirit that he builded enduring monuments.



FIG. 6—The beautiful temple of Hibis, north of the village of Khargeh, in process of restoration: the only building in Egypt which dates from the Persian dynasty.

It is none the less impressive to look down upon piles of débris which include the materials of a city of living inhabitants built at least 5,300 years ago and we know not how much earlier.

It is in Cairo that the traveler will complete his plans for any longer journeys up the Nile or out into the desert. The usual Nile tourist becomes

in most cases a hard-worked trailer in one of the conducted parties either of Cook or of the Hamburg Anglo-American Company, and during a period of three weeks or more he is hurried into caves of rock, where in numbers too large to permit of individual study of the monuments he is forced to listen to unlearned dragomans who lecture in "pidgin English." If he has not by long preparation made himself a specialist in Egyptology, he is likely to retain a confused impression only of the relationships of the many early kings and queens and of the gods and goddesses whose effigies are represented in such bewildering numbers.

The geological or geographical pilgrim, and we venture to say many another, will wisely spare himself time and expense and add both to his knowledge and to his pleasure by keeping clear of the conducted parties and selecting only the more important monuments for his study. He may thus, if he will, include in his itinerary the finest examples of Egyptian monuments with a visit to Khargeh (Kharga) oasis in the Libyan Desert, the "Great Oasis" of the ancients, and continue his journey far up the Nile and across the deserts to Khartum, returning by the Red Sea route to Suez and Cairo, without greater expense in time and money than the conventional tourist must undergo in his Nile journey to the first cataract at Assuan.

A circular ticket to Khartum with return by way of Port Sudan and the Red Sea route should be purchased without the Cairo-Luxor coupon (for which liberal discount is allowed) and the journey begun by rail up the Nile, the traveler stopping at Beni-Hassan and Abydos while en route to Markaz esh-Sharikeh in Khargeh oasis.

No geologist or geographer can afford to miss the opportunity which this side journey to Khargeh affords for becoming familiar with desert conditions. Probably nowhere within easy reach of civilization may so many phases of desert scenery be viewed from a car window and by camel journeys which do not require a camping outfit. It was in the hope of finding minerals and of developing the agriculture of Khargeh that the rich "Corporation of Western Egypt" built this railroad 122 miles in length across the *hamada* from the Nile to the oasis. After two and a half millions of dollars had been spent in development, it was established beyond doubt that valuable minerals were wanting, and the exploitation of the agricultural possibilities developed such difficulties that the project ended in complete failure. Since the railroad has now been acquired by the Egyptian Government, it is likely that the scientist will long have the opportunity to utilize this field for desert studies, despite the disaster to the corporation. If dependence is had upon the trains, three days at least must be devoted to the oasis, where an excellent rest house with all necessary comforts has been established at the headquarters of the company in Markaz esh-Sharikeh, and where every courtesy is extended to travelers. Before visiting the oasis the traveler should carefully read, and if possible

take with him, Dr. John Ball's "Kharga Oasis,"⁸ H. J. L. Beadnell's "An Egyptian Oasis,"⁹ and Walther's above-cited "Das Gesetz der Wüstenbildung."¹⁰ As an antidote against the too strong *penchant* of both Beadnell and Walther to minimize the evidences of recent climatic changes, the student is advised to read Ellsworth Huntington's "The Libyan Oasis of Kharga,"¹¹ with its convenient sketch maps reprinted from Beadnell. The general map from Ball's report is sold separately by the Survey Department of Egypt (Sheet D 4), but the railroad and newer developments are not entered upon it.

The best train from Cairo reaches Oasis Junction (Mowaslet el-Khargeh) in the early evening. As at most other stations along the Nile there are here no accommodations for travelers, and word must be sent in advance by telegraph to the station of Markaz esh-Sharikeh, so that a rail motor car may be in waiting at the station to take the traveler to Kara rest house at the base of the *hamada* escarpment which forms the dividing line between the desert and the fertile plain of the Nile. If sufficient notice is given, this motor car can be used to carry a party of three or four across the entire 122 miles of desert plateau to the oasis, and the journey is thus made in four (instead of six) hours, with the opportunity of stopping at interesting points to make photographs or examinations. This trip can also be made on any day of the week.

On leaving Kara the railroad at first skirts the edge of the alluvial plain of the Nile, then enters the mouth of the broad Wadi Samhūd with its steep rock walls and characteristic flat floor of flood-borne rock débris. As we ascend the walls approach, and one makes out in succession the several beds of the Upper Cretaceous and Lower Tertiary formations which compose the plateau. A bed filled with great melon-shaped flint concretions is easily identified and thus allows us to take note of the scores of small vertical faults at fairly regular intervals with displacements measuring in most cases a few feet only. Among them small flexures can also be made out.

As the line ascends in zigzags we note the wadi vegetation along the floor of the valley,¹² and as the level of each member of the rock series is reached in turn a new color tone characterizes the protective rinds of the desert stones. Once the plateau is reached the flat *hamada* surface stretches away to the westward for nearly a hundred miles with no elevations in sight that rise more than a few feet above the general level. This true mesa is capped by a dense limestone of Eocene age, which has been polished by sand driven by northerly winds until it glistens in the sun like burnished

⁸ Kharga Oasis: Its Topography and Geology, Survey Dept. of Egypt, Cairo, 1900.

⁹ An Egyptian Oasis: An Account of the Oasis of Kharga in the Libyan Desert, With Special Reference to Its History, Physical Geography, and Water Supply. John Murray. London, 1909.

¹⁰ Note especially pp. 30-33, 54, 56, 79, 141, 151, 159, 161, 172, 185, 193, 208-209, 211, and 225.

¹¹ *Bull. Amer. Geogr. Soc.*, Vol. 42, 1910, pp. 641-661.

¹² For a study of this flora see D. T. MacDougal: The Deserts of Western Egypt, *Plant World*, Vol. 16, 1913, pp. 291-303.



FIG. 7.

FIG 7—Mummies, with wrappings removed, lying exposed on desert surface. Scene of vandalism perpetrated by mummy thieves near Ed Deir, Khargeh oasis.



FIG. 8.

A dog mummy still in its wrappings may be seen between the two nearest bodies.

FIG. 8—The unique Christian necropolis north of the village of Khargeh: two hundred tombs laid out in streets.

metal. Wherever locally the surface of the ground is broken into low knobs the effective drilling portion of the sand streams has not been able to surmount them but has glazed the intervening trenches to the height of perhaps a yard, leaving the projecting tops as rough and brown reefs elongated in the wind direction. The parallel bands which stretch westward in considerable numbers on either side of the railway mark the position of the ancient caravan trail across the *hamada*, the camels in caravans being accustomed to maintain fairly uniform intervals in their ranks and to follow with great fidelity the worn tracks of their predecessors.¹³ The loose stones along the route are thus eventually kicked out of the trail, so that it becomes ever more distinctly marked.

Sometimes for many miles the route of the railway crosses areas within which the ground is strewn with ellipsoidal flint concretions, these flints generally averaging a foot or more in diameter, so that they present the appearance of a field of watermelons; they are in fact referred to by the Bedouins as *el botik* (melons).

Near the railway station at kilometer 100 are several isolated sickle-shaped dunes, or *barkhans*, composed of yellow sand, which are connected with others in a far-flung north-to-south train here intersected by the railway. From this part of the plateau mirages are generally visible at mid-day far away to the north, where the greatest expanse of the plain is to be viewed.

As one approaches the western rim of the plateau toward Khargeh oasis low flat-topped hillocks interrupt the surface; these have become undermined by the etching sand blast to form the canopy rocks so characteristic of deserts (Walther's *Baldachinfelsen*). Between them occur distinct basins with alkali deposits.

In the immediate vicinity of the western rim the scenery changes as though by magic and one looks out to the westward as far as the eye can reach over a deep pit excavated from the plateau. On the floor of the pit the eye makes out the dark flecks which indicate the position of oases (Fig. 4) and the yellow bands which represent areas of dune sand, while here and there rise on steep slopes the flat-topped outliers of the plateau. As the train begins to descend into the depression by the Refûf Pass there is seen to the north within the pass what from the distance appears not unlike a black lava stream, but which is in reality an elaborately terraced mass of calcareous tufa. This tufa marks the position where, in a former period characterized by a relatively humid climate, a stream of water poured off the plateau into the basin. Within the tufa are enclosed impressions of leaves, and among them those of the oak, which today is not to be found within Egyptian territory and requires for its growth a relatively humid climate.

¹³ For a striking photograph of camel trails in the desert see Fig. 13, facing p. 487, of W. A. Cannon's article in *Bull. Amer. Geogr. Soc.* Vol. 45, 1913.—EDIT. NOTE.



FIG. 9.



FIG. 10

FIG. 9—Adobe sleeping place of fellaheen constructed as a refuge from serpents, Theban plain.

FIG. 10—Mud cracks in Nile mud sufficiently wide and deep to admit a man's arm to the elbow, Abu Simbel near second Nile cataract.

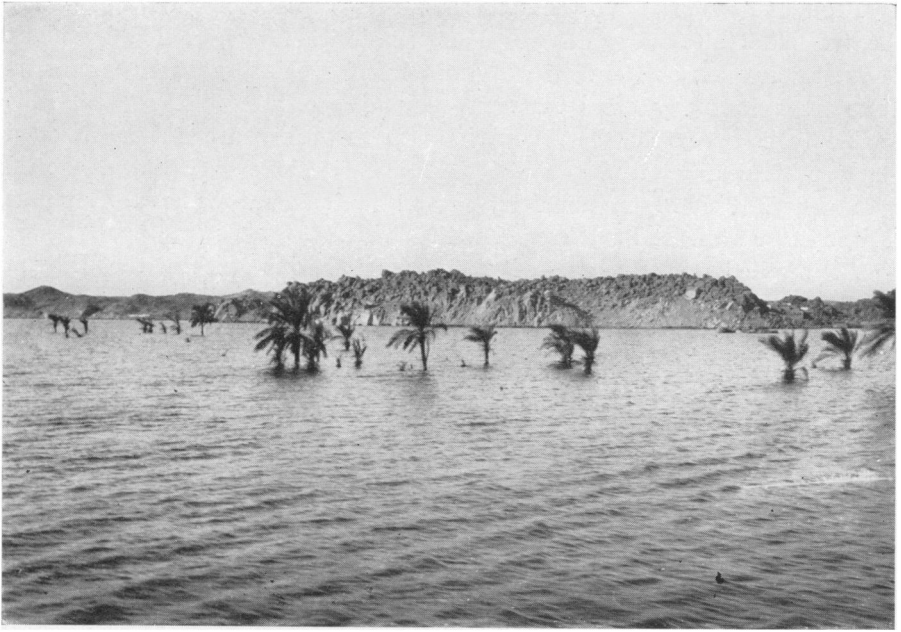


FIG. 11.



FIG. 12.

FIG. 11—Inundated villages with date groves caused by recent elevation of barrage at Assuan. Spheroidal weathering of granite seen on further shore, Nile above Assuan.

FIG. 12—Old landing place at Shellal above Assuan dam showing peculiar spheroidal weathering of granite under desert conditions. Submerged Berber village indicated by the crowns of palm trees rising out of the Nile in the distance.

From the earliest times the oasis has been a place of exile, and today the train deposits its chain gangs of "undesirables" guarded by black Sudanese soldiers at the first oasis station of Meherik. These "undesirables" are in many cases common criminals, and since they would be unable to escape from the depression unaided, they are not imprisoned and are often unfettered when at work. The village barber at Meherik, with a record of seven murders, shaved his patrons while a Sudanese soldier stood near at hand armed with a rifle.

As applied to any one of the several basins within the Libyan *hamada*, the term oasis is clearly a misnomer, for far from being oases they are arid tracts that enclose small "islands" of waving palms that are the true oases. The water for these *ains* is brought to the surface in part by natural springs but more largely by means of true artesian wells. These *ains* constitute less than one per cent of the surface at the bottom of the Khargeh depression. The deeper water-bearing layer found at a depth of several hundred feet beneath the floor of the basin appears to have been tapped in the very earliest times by pipes which had been hollowed from acacia (*sont*) logs cleverly joined to one another. Such constructions betray a high degree of intelligence, and the various ruins would indicate that large and prosperous communities were established in the basin near the beginning of the Christian era. Today the people are idle and in intelligence much inferior to the fellaheen of the Nile Valley. Few of them have sufficient enterprise to journey to the neighboring villages. It is possibly because of this lack of enterprise, though probably more largely owing to the fact that the district has been shielded from tourists, that the idea of *bakshish* is almost unknown.

The principal village is Khargeh, which has a population of 4,500, and with 125 wells supports nearly 45,000 date and *dûm* palms, or nearly two-thirds the entire number growing in the basin. This village is built largely underground as a protection against enemies and resembles a great rabbit warren.¹⁴ In a central square open to the sky there is a rather picturesque mosque (Fig. 3). As one threads his way through the narrow streets he catches glimpses of women untidy of person, but with great gold rings inserted through the nose and wearing necklaces of the same precious metal. Basking in spots reached by the sun are young children whose faces are so covered with flies as to appear like black patches except where the raw surface is exposed.

Like the palms, exotic products of the desert, alfalfa or lucerne is grown and in repeated crops, sometimes as many as twelve in the year; with, in addition, beans, barley, summer wheat, cotton, and sugar cane. Of denizens of the desert there are the acacia (*sont*) trees, tamarisks, and camel grass.

¹⁴ Cf. the account of the underground dwellings of the Matmatas, a Berber tribe living in the Tunisian Sahara, and Figs. 8, 9, and 10 of J. Russell Smith: *The Desert's Edge*, *Bull. Amer. Geogr. Soc.* Vol. 47, 1915 pp. 813-831.—EDIT. NOTE.

Few areas realize the conditions of absolute aridity more perfectly than this basin of the desert, in which the moisture of the air is only about one-fourth of that in Cairo, and where the skin cracks and finger nails quickly become brittle. For a period of at least twelve years no rain has fallen in the inhabited portion of the depression. There is, none the less, abundant evidence that in earlier times the region was more favored by climate and supported a large population. Mention has already been made of the heavy deposits of calcareous tufa which extend for several kilometers downward from the head of the Wadi Refûf on the line of the railway, and that leaves of the oak are encased in these deposits. This can only indicate the course of a stream which fell over the brink of the plateau as a cataract. Somewhat similar deposits have been found at the edge of the plateau above the Nile Valley. Probably dating from the same humid period are extensive lake deposits deeply cut by wind erosion which occupy the valley bottom over considerable areas near Markaz esh-Sharikh and Khargeh. Fragments of pottery and complete utensils which have been exhumed from these lacustrine beds would indicate that the body of water, which at one time reached the level of some 275 feet above the sea, continued well into the historic period, if not into Græco-Roman times.

In order to reach points in the basin along the line of the railway, the traveler may make use of a mule tram to carry his supplies while he makes excursions afield in various directions (Fig. 4).

The beautiful temple of Hibis is situated four kilometers north of the village of Khargeh and is the only building in Egypt dating from the Persian dynasty (521-338 B. C.). Built by Darius the Great and largely buried in sand, this temple has been recently exhumed and restored under the auspices of the Metropolitan Museum of New York, with the co-operation of other societies, aided by the active personal interest of the late Pierpont Morgan. Small though this temple is and half hidden in a grove of date palms, its beauty is such as to call forth the admiration of every lover of art (Fig. 6).

At the unique Christian necropolis, a city of some two hundred tombs laid out regularly in streets (Fig. 8), one gains as nowhere else in the region a conception of the importance, relatively to the present, of the former life of the region. Here as elsewhere in Egypt one is struck by the fact that though we have before us the cities of the dead bespeaking a people of wealth and power, we nowhere find more than a trace of their earthly habitations.

The necropolis gives but a partial idea of the extent of earlier habitations, though it undoubtedly indicates better than anything else the prosperous condition of the inhabitants. Today in Egypt and the Sudan the burial of a man of the people is made as simple as possible. The body is carried out of the village, deposited upon the ground, and a few handfuls

of sand are scooped over it. Thus exposed, the kites and other scavengers soon remove the fleshy portions, leaving the skeleton only. The country is one in which customs have persisted with little change throughout the ages, as perhaps nowhere else upon the globe, and inasmuch as the embalming process involves the use of expensive materials this mode of burial has been restricted to the more prosperous. None the less there are found in other portions of the Khargeh depression simple rock tombs, and in one instance these have been ravaged by mummy thieves in order to secure jewels and other trinkets left upon the bodies. With their wrappings removed the bodies were left scattered over the surface of the desert, presenting the appearance of a small battlefield (Fig. 7).

Aside from questions relating to human occupation, the depression of Khargeh supplies type illustrations of purely desert features, such as armored pebble pavements and canopy rocks, and in addition more unusual features which are dependent upon the nearly constant direction of the wind. Elongated ridges rising abruptly to windward and sloping gradually away to leeward have been carved out of the lake deposits near Markaz esh-Sharikeh. Few, if indeed any, regions offer such advantages for solution of the problem of origin of desert depressions, but the subject must be treated in another place. Before leaving the Khargeh oasis to return across the plateau to the Nile Valley the traveler should make one or more journeys by camel, the most interesting being perhaps that to the old fortress of Ed-Deir so as to pass on the way the butte of Gebel Um el Ghenneima. En route there is opportunity to study sickle-shaped dunes, or *barkhans*, the records of great desert cloudbursts of extremely local extent in deltas of torrential deposits, and, in the notch of the butte, remarkable examples of hoodoo-like spines cut out of limestone containing the hard shells of *Operculina Libyca*. Another trip should be made to the summit of Gebel Ter, where an excellent section of sedimentary formations with their enclosed fossils may be examined.

After returning to the Nile Valley the traveler may continue by rail to Luxor in the Theban plain, where are the remarkable tombs and temples, and from whence either by steamer or by rail the journey may be continued to the First Cataract, with stops at Edfu and Kôm Ombo. It is at Assuan, the ancient Syene, just below the cataract, that the granite first makes its appearance overlain by the Nubian sandstone. The great quarries at this place supplied the builders and sculptors of ancient Egypt, and their half-finished work remains for our inspection when we visit the quarries. Opposite Assuan is the granite island of Elephantine, with its interesting pot holes, which were made the subject of an important study by Professor Jean Brunhes.¹⁵ The granite of this district, after extensive erosion, was overlain by the Nubian sandstone, and the channels within the granite which are followed by the river are marked out either as lines

¹⁵ Le travail des eaux courantes, *Mém. Soc. Fribourgeoise des Sci. Nat.*, 1902, pp. 153-224.

of faulting or as zones of closely spaced dikes composed of more basic igneous rock, such as basalt.¹⁶

If the desert route to the Nile dam or barrage at Shellal be taken, one follows for a large part of the way the right bank of the cataract, with abundant opportunity to observe the blackened crust or rinds formed upon the surface of the granite within the range of the inundations. These rinds have been found to consist chiefly of manganese dioxide together with ferric oxide, lime, silica, magnesia, and traces of other substances.¹⁷

The effect of the latest addition to the barrage has been to raise the level of the water impounded above it by some five meters, submerging many villages whose position is indicated today by the crowns of date palms projecting above the water (Figs. 11 and 12). The characteristic weathering forms of the granite are spheroidal blocks regularly piled together. For days the half-submerged palm groves and these weathered masses give character to the landscapes viewed from the steamer en route to Wadi Halfa. At Abu Simbel, forty miles below Halfa, is the rock temple which is perhaps the finest of all the monuments of ancient Egypt. From Halfa the journey is continued by *train de luxe* across the sand desert to Khartum and thence eastward to the Red Sea at Port Sudan, the newly created harbor near Suakin. This portion of the journey is so well covered by Walther in his "Das Gesetz der Wüstenbildung"¹⁸ that it is unnecessary to treat the subject here. The traveler returns from Port Sudan by way of the Red Sea to Suez and Cairo, thus completing a circular tour.

¹⁶ John Ball: A Description of the First or Aswan Cataract of the Nile, Survey Dept. of Egypt, Cairo, 1907.

¹⁷ A. Lucas: The Blackened Rocks of the Nile Cataracts, Survey Dept. of Egypt, Cairo, 1905.

¹⁸ Especially pp. 66, 72-75, 107-109, 153, 244, 285.